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(54) Method of and apparatus for testing laminated magnetic cores

(57) A laminated magnetic core, e.g. the stator core 10 of an electric rotating machine, is tested for hot spots by inducing in the core an alternating flux parallel to the laminations. Flux in a certain direction and at a selected location on the surface of the core is then detected and the component in phase quadrature with the mean leakage flux is indicated to identify the presence of a hot spot. Apparatus for performing the method has an excitation winding for inducing the alternating flux, a reference coil for detecting the mean leakage flux and a pair of pick up coils which are connected together in series opposition to sense the spacial gradient of the detected flux. The pick up coils are traversed along successive pairs of the teeth 12 on the inside surface of the core to locate hot spots. The voltage developed across the pick up coils is amplified and fed to the signal input of a phase sensitive detector to the reference input of which is applied the integrated voltage developed across the reference coil.

FIG. 1.

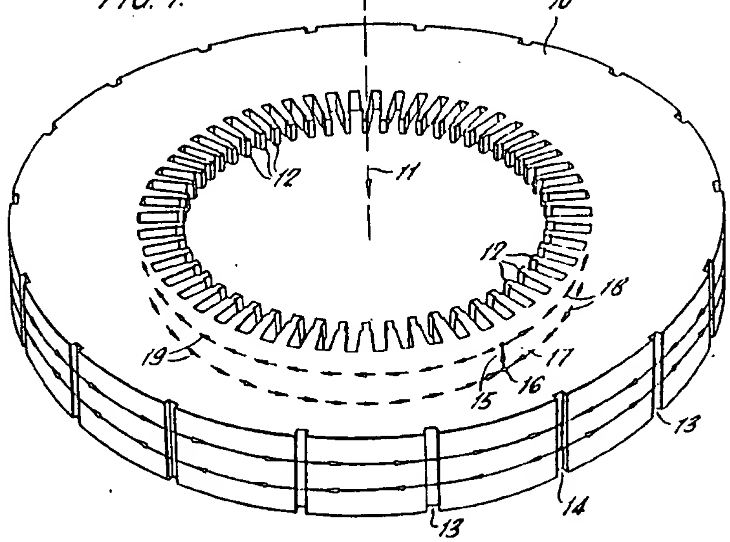

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FIG. 1.

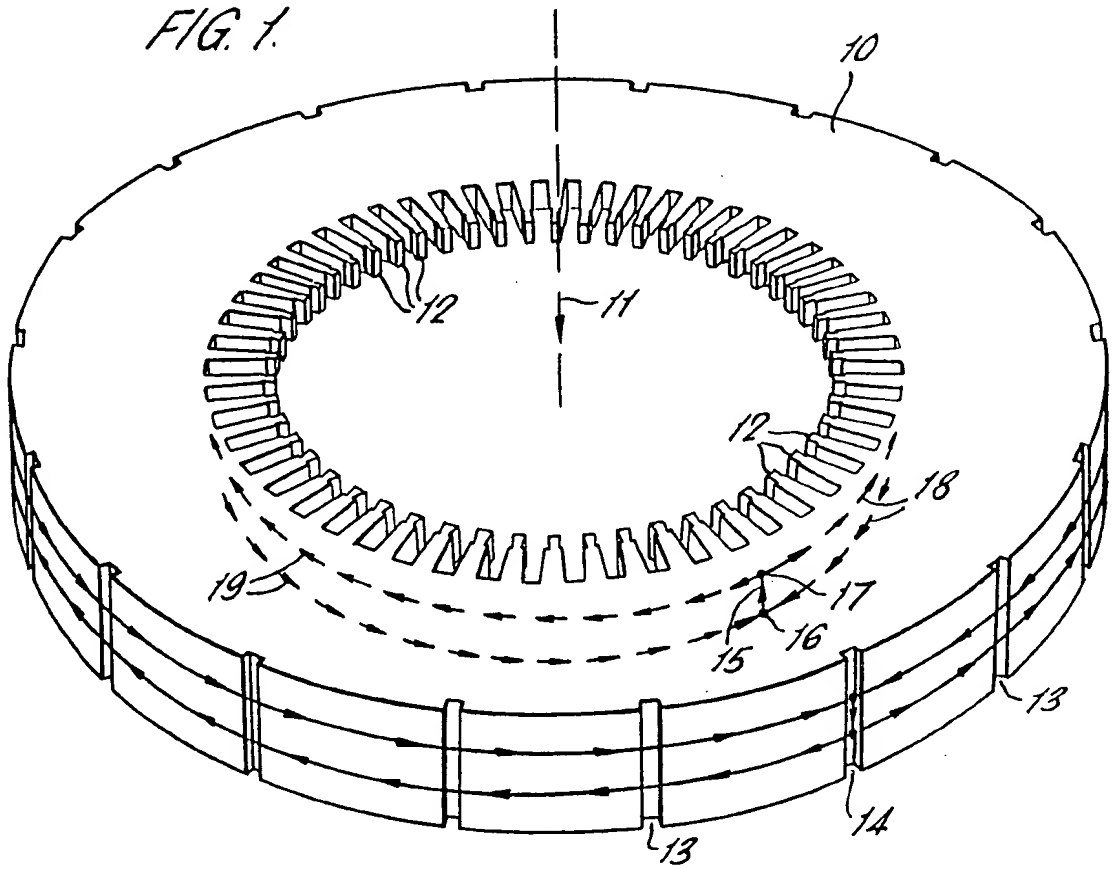


FIG. 2.

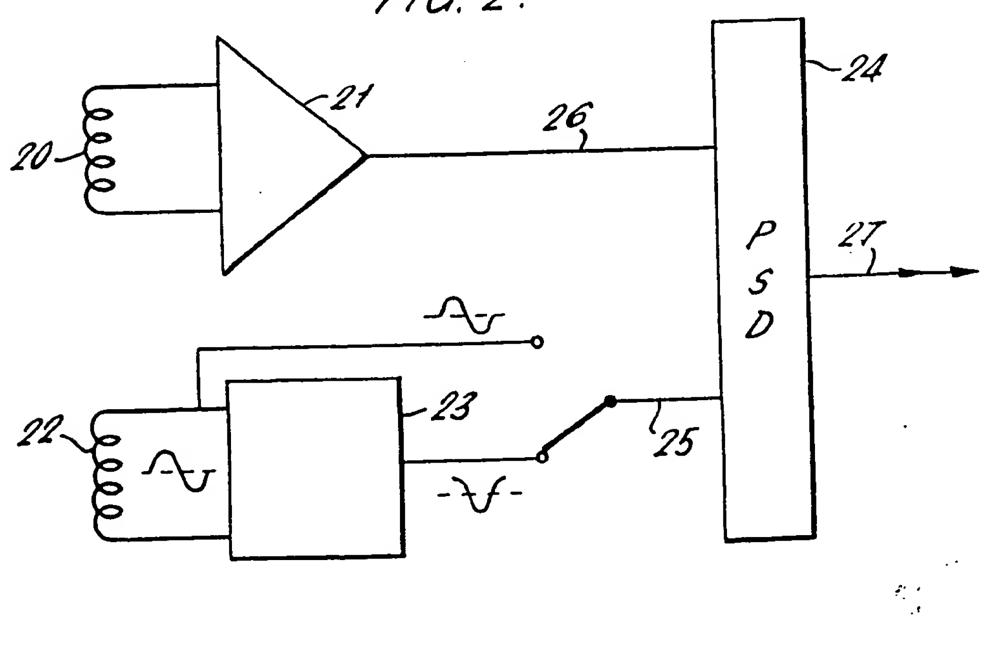


FIG. 3a

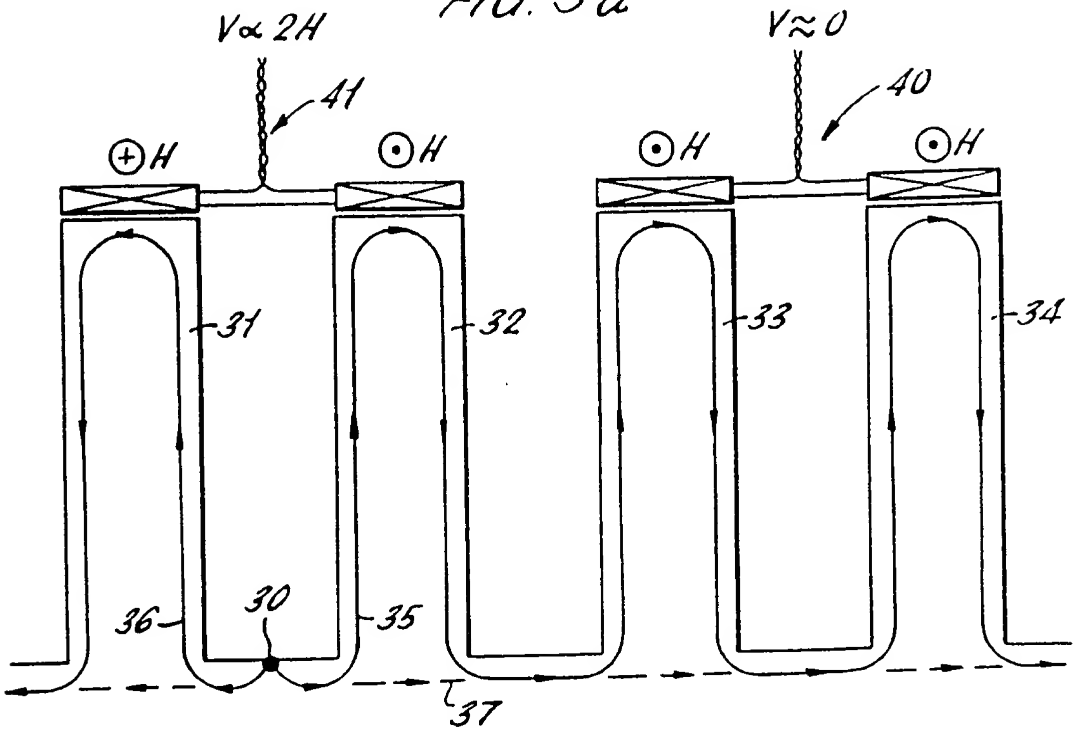


FIG.3b.

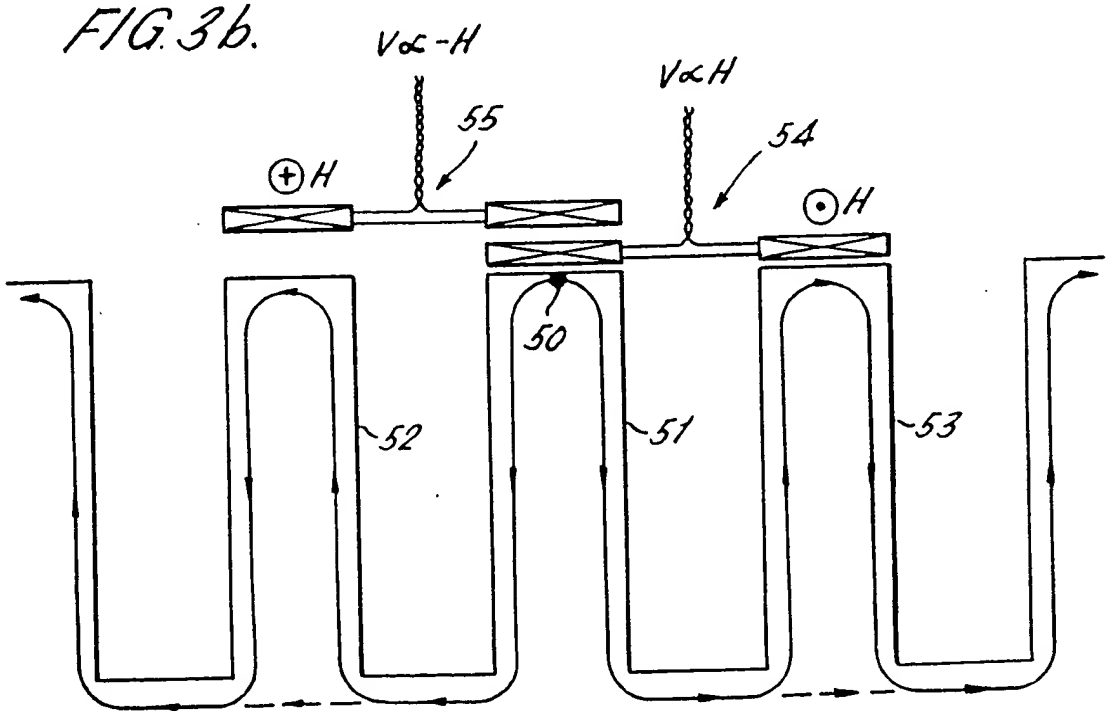
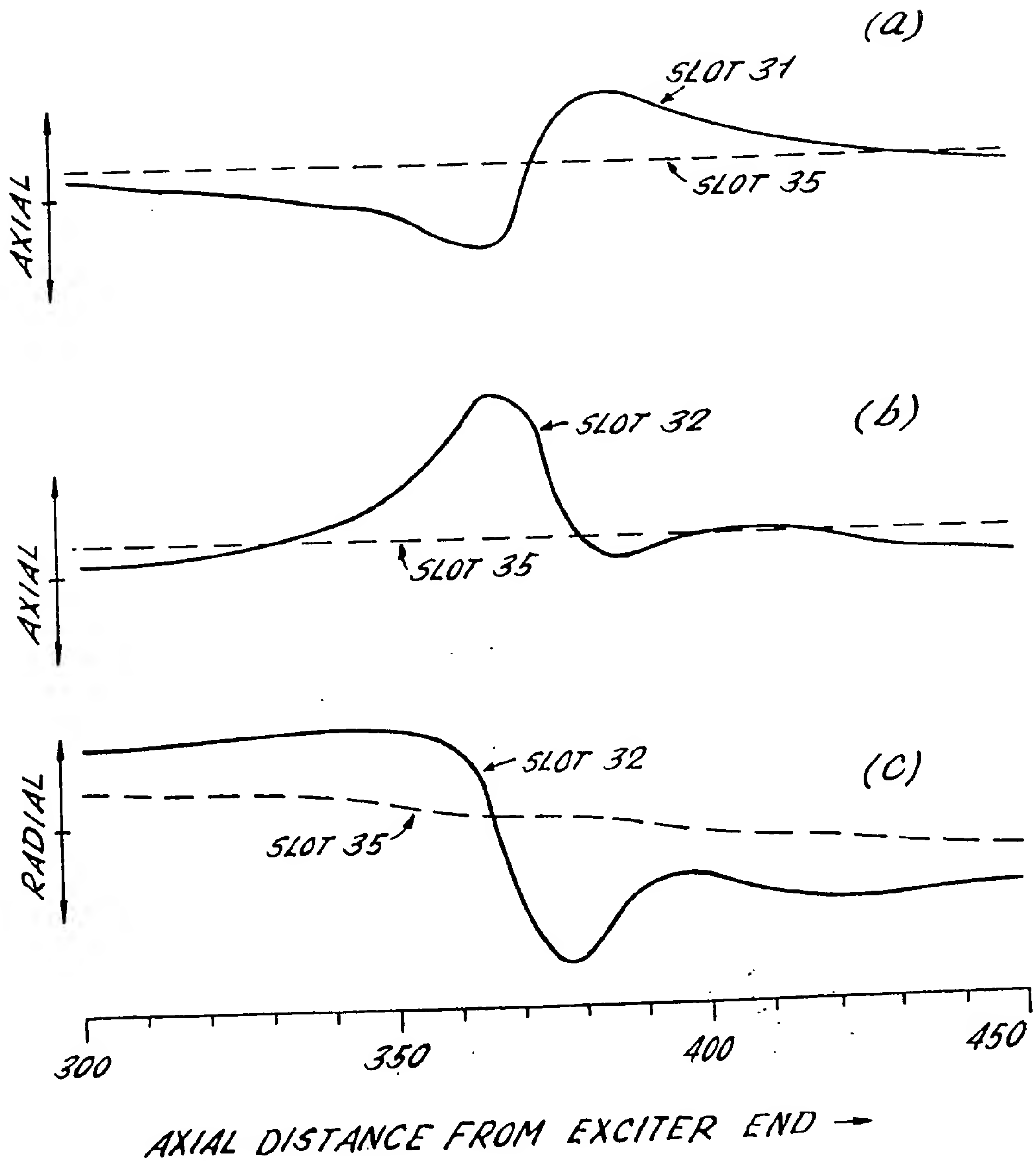


FIG. 4.


(a)
SLOT 31
SLOT 35
AXIAL
(b)
SLOT 32
SLOT 35
AXIAL
(c)
SLOT 32
SLOT 35
RADIAL
300
350
400
450
AXIAL DISTANCE FROM EXCITER END →

SPECIFICATION

Method of and apparatus for testing laminated magnetic cores

The present invention relates to a method of and apparatus for testing laminated magnetic cores. It is important, especially in the magnetic cores of large rotating electric machines, to be able to test these cores for "hot spots". "Hot spots" can occur when the insulation between adjacent laminations in the core has broken down or is defective so that current can flow between laminations. The current is driven by the magnetic flux in the plane of the laminations generated when the machine or apparatus containing the core is operating. Such currents are generally only troublesome when laminations are connected together at locations spaced apart across the direction of the flux so as to complete a circuit linking a substantial amount of the flux in the core. It is common, in the stator cores of electrical rotating machines, such as generators, for the laminations to be electrically connected at their outside edges where they are clamped to the building bars via key bars. These electrical connections are quite deliberate in some cases but in others they can be formed in a rather random manner as the insulation at the edges of the laminations becomes abraded or otherwise degraded during operation of the machine. Thus, in the stator cores of rotating machines, hot spots are normally only serious when occurring at locations towards the inside circumference of the core.

In the past, such hot spots have been detected in the stator cores of electrical generators by exciting the core with a "ring flux" that is to say an alternating magnetic flux extending circumferentially around the core. If this flux is sufficiently large the currents generated at the hot spots is sufficient to produce local heating which can be detected by an infra red camera. However, this technique requires relatively high excitation currents to produce the ring flux, entailing the provision of a heavy duty coil and power supplies. Further, the technique can be insufficiently sensitive to detect hot spots which are seated deeply underneath the internal circumferential surface of the core.

According to one aspect of the present invention, a method of testing a laminated magnetic core comprises the steps of inducing in the core an alternating magnetic flux parallel to the laminations by driving an alternating electric current in an excitation winding, detecting the magnetic flux in a predetermined component direction at a selected location on a surface of the core normal to the laminations, monitoring the mean leakage magnetic flux outside the materials of the core and indicating the magnitude of the component of the detected flux which is in phase quadrature with the mean leakage flux.

The mean leakage flux is the leakage flux, in the air (usually) outside the material of the core, averaged over a large surface area of the core so as to be relatively insensitive to the effects of any local hot spots in the core.

It will be appreciated that if there are no "hot spots" in the core, only relatively small eddy currents will be generated in the core by the alternating flux parallel to the laminations. However, if there is an insulation breakdown between adjacent laminations in the core, the flux will produce a current between laminations at the location of the fault, provided that the laminations are otherwise mutually interconnected to complete a circuit linking the flux. These currents induced in the core will themselves produce magnetic flux at said surface of the core which is not in phase with the mean leakage flux. Thus, if the detected flux includes flux generated by these hot spot currents, it will have a component in phase quadrature with the mean leakage flux, and so the method of the invention can be used to indicate the presence of hot spots in the core. Preferably, the predetermined component direction at which magnetic flux is detected is at right angles to the direction of the induced flux in the core. Further, it is commonly convenient for the induced flux to be parallel to said surface at which flux is detected. It is also especially convenient if said predetermined component direction is normal to the surface.

Preferably, the method includes the step of traversing across said surface said location at which flux is detected to locate any point or points on the surface where the phase of said component of the detected flux reverses. Current tends to flow to and from the hot spot in the plane of the laminations of the core and this current flowing in the laminations tends to flow generally symmetrically on opposite sides of a plane normal both to the surface of the core and to the laminations and containing the hot spot. Since the current in the laminations is flowing in opposite directions on either side of this plane, the flux produced by this current is in opposite directions on either side of the plane and the plane can be located by observing the position where the phase reverses. Further, the current flows in opposite directions in the laminations at opposite "ends" of the hot spot; that is to say, at any instant, current can be flowing into the hot spot from laminations at one end thereof and out of the hot spot in laminations at the other end. Thus the phase of said detected flux component is also opposite on either side of a plane parallel with the laminations and containing the hot spot. It can be seen therefore that it should be possible to locate the point on the surface of the core nearest to the hot spot even when the hot spot is itself well within the body of the core.

Conveniently, the location at which flux is detected is traversed in successive parallel paths normal to the laminations. Further, it is convenient if the detecting step includes sensing the spacial gradient of the magnitude of the phase component in the direction parallel to the laminations. This latter producedure is useful because it has been found that currents flowing in the laminations towards and away from a hot spot can produce detectable components at a considerable distance away from the location of the hot spot. The variation in this flux may be quite small making it rather difficult to locate the actual position of the hot spot at least in the direction of the laminations. However, if the spacial

gradient in this direction of the phase component is sensed, this gradient increases very markedly only in the vicinity of the hot spot location, where the phase reverses.

As mentioned previously, the present invention is especially useful for testing the magnetic stator cores of rotating electric machines. Such stator cores are commonly formed with a plurality of regularly spaced axial teeth pointing radially inwards about their internal circumferences. When applying the method of the present invention to such stator cores the induced magnetic flux is circumferential about the core and said surface of the core at which flux is detected is the internal circumferential surface. Conveniently in such stator cores, the location at which flux is detected is traversed axially along successive teeth of the core; and conveniently also for each axial traverse, said flux detected at a respective adjacent pair of teeth is compared. If the two teeth of the adjacent pair being compared are both on the same side of a hot spot then the fluxes detected at each tooth of the pair will be of the same sign and of substantially the same magnitude. However, in the immediate vicinity of a hot spot the flux at an adjacent pair of teeth will be markedly different.

According to a further aspect of the present invention, apparatus for testing laminated cores comprises an excitation winding and means for driving an alternating electric current therein, the excitation winding being positionable to induce in a core to be tested an alternating magnetic flux parallel to the laminations, means for detecting the magnetic flux in a predetermined component direction at a selected location on a surface of the core normal to the laminations, means for monitoring the mean leakage magnetic flux outside the material of the core, and means for indicating the magnitude of the component of the detected flux in phase quadrature with the mean leakage flux.

Conveniently, the excitation coil is positionable in relation to the core to induce flux in the core parallel to said surface.

Further conveniently, said means for detecting includes a pick up coil positionable adjacent said surface with its axis in said predetermined component direction. Said means for detecting may include a second pick up coil connected in series opposition with said first mentioned pick up coil, the two coils being positionable together adjacent said surface with both their axes in said predetermined direction and spaced apart in the direction parallel to the laminations. In this way, if both coils are in regions where the detectable flux has substantially the same phase and magnitude, then the voltage produced across the two pick up coils will be substantially zero. However, where the two coils are in respective regions of different flux, e.g. near a hot spot where the phase of said quadrature component of the detected flux reverses, then a corresponding voltage is produced across the two coils.

Preferably, said means for indicating includes a phase sensitive detector connected to reject the phase component of the voltage across the pick up coil or coils which is in quadrature with the mean leakage flux. The phase sensitive detector arranged in this way is effective to reject the phase components of the voltage across the pick up coil corresponding to flux linking the coil which is in phase with the mean leakage flux. The apparatus is therefore made more sensitive to flux produced by currents flowing in hot spots in the core. The means for indicating may further include a reference coil which is large in cross-section relative to the pick up coil or coils and is positionable to be linked by leakage flux outside the material of the core, and connected to the reference input of the phase sensitive detector *via* an integrator.

The apparatus may include means for traversing said pick up coil or coils across said surface of the core and said traversing means may be arranged to traverse the pick up coil or coils in successive parallel paths normal to the laminations.

Then the apparatus may further include means for plotting the output signal from the phase sensitive detector against the position of said coil or coils along each said parallel path of traverse.

The present invention further envisages apparatus for testing laminated stator cores of rotating electric machines, such a core having a plurality of regularly spaced axial teeth pointing radially inwards about its internal circumference, the apparatus comprising an excitation coil positionable in relation to the core for inducing therein alternating magnetic flux parallel with the laminations of the core and directed circumferentially around the core, means for driving an alternating current in the excitation core to produce said flux, a pick up coil positionable at a selected location adjacent the internal circumferential surface of the core and with its axis in a predetermined direction relative to said surface at the location, a reference coil having a cross-section which is large relative to that of the pick up coil and positionable to monitor the mean leakage flux outside the material of the core, and means for indicating the magnitude of the component of the voltage induced across said pick up coil which is in phase quadrature with the voltage induced across the reference coil. The apparatus may further include a second pick up coil connected in series opposition with said first mentioned pick up coil, the two coils being positionable with both their axes in said predetermined direction and spaced apart, circumferentially relative to said internal core surface, by an amount selected to correspond to the spacing of teeth in the core to be tested. The apparatus may then include means for traversing said pick up coils axially along a selected pair of teeth of the core.

A single pick up coil which has a small cross-section relative to the teeth of the core may be employed for accurately locating the position of the hot spot on an individual tooth.

An example of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a perspective view of part of a laminated stator core for an electrical generator.

Figure 2 is a schematic block diagram of the sensing circuit of an apparatus for testing a laminated core,

Figures 3a and *3b* show the pick up coils of the apparatus of Figure 2 and illustrate how these coils respond to faults occurring at various locations in the magnetic core, and

Figure 4 is a graphical representation of magnetic flux sensed by the apparatus of Figure 2 versus the axial distance of the pick up coils along the core.

To assist in the understanding of the present invention and particularly of the example of the invention to be described below, an explanation will now be given of how currents are thought to flow in the laminations of a core which has a hot spot, i.e. a low resistance path between a number of the laminations. Referring to Figure 1, there is shown a portion 10 of the core of an electric generator. In practice a complete generator core has a much greater axial extent than the portion illustrated in Figure 1. The core is symmetrical about its axis 11 and comprises laminations extending in planes perpendicular to the axis. The inner circumference of the core is formed as a series of axially extending teeth 12 spaced evenly about the internal circumference and directed radially inwards towards the axis 11. The outer circumference of the core is formed with a number of axially extending slots 13 evenly spaced about the periphery and in the complete core these are used to accommodate key bars to hold the laminations of the core together and for mounting the core in the building bars of the complete electrical machine. In Figure 1, none of the key bars is shown but it is to be assumed that there is at least a key bar in the slot 14 which in effect connects together all the laminations of the stack 10 at this point.

It is assumed that there is a hot spot in the stack 10 inter connecting a number of adjacent laminations to form a conducting path 15 between the laminations extending substantially parallel with the axis 11. In Figure 1, this path 11 is shown having a considerable axial extent although in practice the hot spot may extend over only a short distance relative to the full axial extent of the core.

If the stack 10 formed part of the stator core of an operating electrical machine, magnetic flux would be produced in the core extending circumferentially around the core in the plane of the laminations. It can be seen, therefore, that the path 11 of the hot spot forms together with the key bar in the slot 15 a circuit which links a substantial proportion of the flux in the stack 10. As a result, current is caused to flow along the path 15. At a selected instant this current can be considered to flow along the path 15 in the direction of the arrow indicated in the Figure. In order to provide this current flowing in the path 15 current will flow in the laminations of the stack 10 towards one end 16 of the path 15 and in other laminations away from the other end 17 of the path. The current flowing in the laminations in the immediate vicinity of the hot spot can be considered as flowing in all directions towards and away from the hot spot. Further, this theoretical current flow in the laminations can be divided into a first component flow circumferentially around the core and a second component flow radially inwards and outwards relative to the axis 11 of the core. In Figure 1, only the circumferential components of the flow are indicated by the arrows 18 and 19. The circumferential flow can be considered as extending on either side of the hot spot a substantial distance about the circumference of the core and there would be a corresponding circumferential flow in the opposite direction at the outer periphery of the core towards and away from the key bar in the slot 14. It will be appreciated that this circumferential current flow towards and away from the hot spot produces magnetic flux inside the inner circumference of the stack 10 and which extends both radially and axially relative to the stack. Since the circumferential current flow extends circumferentially a considerable distance away from the location of the hot spot corresponding magnetic flux is produced also over a wide arc.

In fact, this magnetic flux, which is in phase quadrature with the overall mean leakage flux, can be observed to extend over such a wide arc, as indicated by the postulated circumferential current flow. However, the distribution of the observed magnetic flux can also be explained by considering only the theoretical leakage of flux at the interior core surface from the flux generated by the local hot spot current.

In order to test the core 10 to locate the hot spot, a circumferentially extending alternating magnetic flux is produced in the core to link with the circuit formed in the stack 10 by the path 11 of the hot spot. A similar circumferential or "ring" flux is produced also in the known method of testing stator cores used hitherto, i.e. that employing an infra red camera. However, hitherto it has been necessary to provide a relatively large flux to ensure that sufficient heating is produced in any hot spots to be detectable by the camera. This has entailed the provision of substantial excitation windings on the core to produce the flux in the core and also has required a considerable energy from the power supply. However, in the method of the present invention it is necessary only to produce a relatively low flux in the core and testing has been carried out successfully with flux sufficient only to induce a voltage in a single turn trace winding of about 5 volts r.m.s. per metre of core, i.e. typically 30-35 volts for the stator core of a 500 or 660 megawatt generator. This can typically be provided by between 3 and 6 turns in an excitation winding of cable with a 20 ampere rating. The current required is typically 10 to 20 amps. In fact much higher flux levels in the core should be avoided since the amount of leakage flux produced would increase disproportionately and, further, harmonic distortion is introduced in the flux and resulting electric currents which would complicate the interpretation of the test results.

In order to test the stack 10 for hot spots, the magnetic flux in the air at locations adjacent the internal circumferential surface of the core is detected and compared with the mean leakage flux in the air produced directly by the excitation winding. It will be appreciated that any flux resulting from electrical currents induced in the core at hot spots will have a phase difference relative to the mean leakage flux, which will itself tend to be in phase with the driving current in the excitation winding. Thus,

flux produced by hot spot currents is detected by indicating the magnitude of the component of the detected flux which is in phase quadrature with the mean leakage flux.

Referring now to Figure 2, the flux at the internal circumferential surface of the core is detected by a search or pick up coil 20 and the voltage induced across the search coil is amplified by an amplifier 21. A reference oil 22 is located near the excitor coil so as to monitor the mean leakage flux so that a voltage is induced across the reference coil which is in quadrature with the leakage flux. The voltage across the reference coil 22 is supplied to an integrator 23 the output of which is then a signal in phase with the leakage flux. A phase sensitive detector 24 is employed to indicate the magnitude of the component of the flux detected by the search coil 20 which is in phase quadrature with that linking the reference coil 22. The output of the integrator 23 is supplied to the reference signal input 25 of the phase sensitive detector and the output of the amplifier 21 is supplied to the "signal" input 26. If the flux detected by the search coil 20 is in phase with the leakage flux linking the reference coil 22, then the voltage signal supplied to the signal input 26 of the phase sensitive detector 24 will be in phase quadrature with the reference signal to the input 25, and the output of the detector 24 on the output line 27 will be substantially zero. Only if the signal on the signal input 26 is other than in phase quadrature with the reference signal to the input 25 will the detector produce an output.

It will be appreciated that even in a perfect core there will be some leakage from the main excitation flux which will be detected by the search coil 20. The phase sensitive detector 24 is effective to discriminate against such leakage flux which will be in phase with the mean leakage flux detected by the reference coil. Normally the search coil is orientated with its axis extending radially towards the centre of the core or extending axially along the length of the core so as to detect radial or axial magnetic flux respectively.

The design and positioning of the reference coil 22 is not critical. The coil can be large e.g. 100 mm diameter, and should have a high output, e.g. 1 to 10 V/m T, so that little pre-amplification is required. The coil may be rested near the bottom of the bore of a stator coil several teeth away from the excitation winding so as to monitor the radial leakage field. Alternatively, the reference coil may be orientated to monitor the circumferentially extending leakage flux.

In order to locate a hot spot, the search coil is traversed about the internal circumferential surface of the core. It has been found convenient to traverse the coil in successive axial paths parallel with the teeth of the core. As the search coil passes over a hot spot, the phase of the flux component indicated by the detector 24 will reverse. This is because the currents producing the detected flux component flow in opposite direction on either side of a hot spot.

Because the circumferential currents, to and from a hot spot, extend a considerable distance on either side of the hot spot it is preferable to form the search coil as two separate coils connected in series opposition. The coils are mounted with their axes parallel and are spaced apart so that they register with adjacent teeth at the same axial distance along the core. The axial extent of the pick up coils is preferably small (typically less than 5 mm) so that small hot spots can be detected and accurately located along the bore of the core. However, the coils should also have a high sensitivity and hence a rectangular former is used almost as wide as a tooth. In a typical example, each coil is 25 mm wide by 4 mm deep and has an axial extent of 4 mm. Each is wired with 850 turns of 0.002 Inch diameter wire to give a sensitivity of about 30 V/T.

Figures 3(a) and (b) illustrate the two search coils in various positions relative to a hot spot. Referring to Figure 3(a), four adjacent teeth of a stator core are illustrated in cross section at the axial location of a hot spot 30. The teeth are numbered 31, 32, 33 and 34. Currents flowing in the laminations out of one end of the hot spot are indicated by lines 35 and 36.

The current is shown flowing up and down each tooth on either side of the hot spot. In fact it is thought that the current tends to flow along the roots of the teeth as indicated by the dotted lines 37, but that these currents 37 flowing in any particular lamination tend to induce in the adjacent laminations currents circulating up and down the teeth. Thus the overall effect is still rather as illustrated.

Considering the search coils, referenced 40, located with one coil above each of the teeth 33 and 34, it can be seen that each coil is exposed to magnetic flux flowing in substantially the same direction at any instant, i.e. flux of the same phase. Since the two coils are in series opposition the resultant voltage induced across the coils is therefore approximately zero. However, considering the two coils, referenced 41, located above teeth 31 and 32, it can be seen that the coils are exposed to flux of opposite sign since the currents in teeth 31 and 32 are flowing in opposite directions. As a result, the voltage induced across the coils is proportional to twice the voltage induced in each coil. It will be appreciated therefore that the provision of two coils connected in series opposition enables the location of the hot spot to be detected with greater accuracy since the voltage is induced across the coils only when they are located over teeth in the immediate vicinity of the hot spot.

The Example of Figure 3(a) shows a hot spot located at the root between teeth 31 and 32. In such an example, a voltage is induced across the coils only when the two coils are located above the teeth on either side of the hot spot. Referring to Figure 3(b), there is shown a corresponding arrangement when the hot spot, referenced 50 is located in the centre of a tooth 51. The teeth on either side of tooth 51 are referenced 52 and 53.

Since each coil of the sensor coils extends substantially the full width of a tooth, it can be seen that the coil located immediately over the hot spot 50 is exposed to substantially zero magnetic flux, since equal and opposite currents are flowing in the tooth towards and away from the hot spot. Thus, when the search coils are in the position indicated by reference 54, the voltage induced across the coils is

substantially equal to that induced across the coil over the tooth 53. However, the voltage induced across the coils when in the position referenced 55 will be substantially equal and opposite to that of position 54. When the coils are located over teeth further away from the tooth 51, the voltage will be substantially zero. It can be seen therefore that the two coils can be used to determine whether the hot spot is located in a particular tooth or beneath a slot between a pair of teeth.

In a practical arrangement, the two coils are mounted on a carriage by which they can be traversed axially along successive adjacent pairs of teeth. In order to plot the results of a test it is convenient to emply an xy plotter in which the x axis of the plotter is connected to respond to a voltage proportional to the axial position of the pick up probe along the stator core. This voltage can be derived from any simple mechanical transducer. The output of the phase sensitive detector is connected to the y axis. Thus, repeated plots are made on the plotter corresponding to successive axial traverses of the pick up coils along adjacent pairs of teeth. Preferably, respective axial plots are taken with the pick up coils orientated to detect both radially extending and axially extending fields.

Figure 4 shows graphically examples of plots obtained using the apparatus and method described. The top graph (a) is a plot of the output of the phase sensitive detector when detecting the axial field and with the coils traversed along the two teeth either side of a slot numbered 31. For comparison, the plot is also given of the axial field for the traverse along the teeth either side of slot 35. In (b) a corresponding plot is shown for the traverse along the teeth either side of slot 32, which immediately neighbours slot 31 and at (c) a plot is given of the radial field for slot 32, and for comparison the radial field for slot 35. The axial distance along the core from the end at which the excitor coil is mounted is given in millimetres along the x axis. The plots clearly indicate a hot spot at the tooth between slots 31 and 32 at a distance of about 370 mm from the excitor end of the core.

When a hot spot has been located by the procedure described above, its precise position on a tooth or in a slot can be investigated using a single pick up coil of smaller dimensions.

CLAIMS

1. A method of testing a laminated core comprising the steps of inducing in the core an alternating magnetic flux parallel to the laminations by driving an alternating electric current in an excitation winding, detecting the magnetic flux in a predetermined component direction at a selected location on a surface of the core normal to the laminations, monitoring the mean leakage magnetic flux outside the material of the core and indicating the magnitude of the component of the detected flux which is in phase quadrature with the mean leakage flux.

2. A method as claimed in claim 1 wherein the predetermined component direction at which magnetic flux is detected is at right angles to the direction of the induced flux in the core.

3. A method as claimed in either of claims 1 and 2, wherein the induced flux is parallel to said surface at which flux is detected.

4. A method as claimed in any preceding claim wherein said predetermined component direction is normal to the surface.

5. A method as claimed in any preceding claim and including the step of traversing across said surface said location at which flux is detected to locate any point or points on the surface where the phase of said component of the detected flux reverses.

6. A method as claimed in claim 5 wherein the location at which flux is detected is traversed in successive parallel paths normal to the laminations.

7. A method as claimed in any preceding claim, wherein the detecting step includes sensing the spacial gradient of the magnitude of the phase component in the direction parallel to the laminations.

8. A method of testing a magnetic stator core of a rotating electric machine comprising the method of any of claims 1 to 4 wherein the induced magnetic flux is circumferential about the core and said surface of the core at which flux is detected in the internal circumferential surface.

9. A method as claimed in claim 8 wherein the location at which flux is detected is traversed axially along successive teeth of the core.

10. A method as claimed in claim 9 wherein, for each axial traverse, said flux detected at a respective adjacent pair of teeth is compared.

11. Apparatus for testing laminated cores comprising an excitation winding and means for driving an alternating electric current therein, the excitation winding being positionable to induce in a core to be tested an alternating magnetic flux parallel to the laminations, means for detecting the magnetic flux in a predetermined component direction at a selected location on a surface of the core normal to the laminations, means for monitoring the mean leakage magnetic flux outside the material of the core, and means for indicating the magnitude of the component of the detected flux in phase quadrature with the mean leakage flux.

12. Apparatus as claimed in claim 11 wherein conveniently, the excitation coil is positionable in relation to the core to induce flux in the core parallel to said surface.

13. Apparatus as claimed in claim 11 or claim 12, wherein said means for detecting includes a pick up coil positionable adjacent said surface with its axis in said predetermined component direction.

14. Apparatus as claimed in claim 13 wherein said means for detecting includes a second pick up coil connected in series opposition with said first mentioned pick up coil, the two coils being positionable together adjacent said surface with both their axes in said predetermined direction and spaced apart in the direction parallel to the laminations.

15. Apparatus as claimed in either of claims 13 or 14 wherein, said means for indicating includes a phase sensitive detector connected to reject the phase component of the voltage across the pick up

coil or coils which is in quadrature with the mean leakage flux.

16. Apparatus as claimed in any of claims 13 to 15 wherein the means for indicating further includes a reference coil where is large in cross-section relative to the pick up coil or coils and is positionable to be linked by leakage flux outside the material of the core, and connected to the reference input of the phase sensitive detector *via* an integrator.

17. Apparatus as claimed in any of claims 13 to 16 and including means for traversing said pick up coil or coils across said surface of the core.

18. Apparatus as claimed in claim 17 wherein said traversing means is arranged to traverse the pick up coil or coils in successive parallel paths normal to the laminations.

19. Apparatus as claimed in claim 18 and including means for plotting the output signal from the phase sensitive detector against the position of said coil or coils along each said parallel path of traverse.

20. Apparatus for testing laminated stator cores of rotating electric machines, such a core having a plurality of regularly spaced axial teeth pointing radially inwards about its internal circumference, the apparatus comprising an excitation coil positionable in relation to the core for inducing therein alternating magnetic flux parallel with the laminations of the core and directed circumferentially around the core, means for driving an alternating current in the excitation core to produce said flux, a pick up coil positionable at a selected location adjacent the internal circumferential surface of the core and with its axis in a predetermined direction relative to said surface at the location, a reference coil having a cross-section which is large relative to that of the pick up coil and positionable to monitor the mean leakage flux outside the material of the core, and means for indicating the magnitude of the component of the voltage induced across said pick up coil which is in phase quadrature with the voltage induced across the reference coil.

21. Apparatus as claimed in claim 20 and further including a second pick up coil connected in series opposition with said first mentioned pick up coil, the two coils being positionable with both their axes in said predetermined direction and spaced apart, circumferentially relative to said internal core surface, by an amount selected to correspond to the spacing of teeth in the core to be tested.

22. Apparatus as claimed in claim 21 and including means for traversing said pick up coils axially along a selected pair of teeth of the core.

23. A method of testing a laminated magnetic core substantially as hereinbefore described with reference to the accompanying drawings.

24. Apparatus for testing laminated magnetic cores substantially as hereinbefore described with reference to the accompanying drawings.

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